Colorado Ultraviolet Transit Experiment: Mass-loss and Magnetic Fields in Exoplanetary Systems

Completed Technology Project (2017 - 2020)

Project Introduction

We propose a four year suborbital-class research program to develop, launch, and operate a cubesat mission to study the atmospheric properties of planets orbiting other stars. Exoplanets in short-period orbits (Prot = 1 – 5 days) provide a unique opportunity to observe phenomena critical to the development and evolution of our own solar system writ large, including atmospheric mass-loss, interaction with the host star, and possibly even planetary magnetism. Hot Jupiters and Hot Neptunes are laboratories for studying the physics of atmospheric escape. Owing to their large sizes and short-periods, the physics of atmospheric mass-loss can be studied at with a dedicated small instrument. Observations of short-period planets have found them to be greatly inflated, extended to several planetary radii in some cases. Systems with light curves showing late-egress relative to their optical transit have been modeled as comet-like "tails" that form as the planet's extended atmosphere extends beyond the Roche lobe and escapes into interplanetary space. Early-ingress observations may also indicate rapid mass-loss, but have been alternatively interpreted as evidence for a magnetically-supported bow shock ahead of the planet's orbital motion. These processes cannot be observed in broad-band optical light curves (e.g., with Kepler). The Colorado Ultraviolet Transit Experiment (CUTE) is designed to spectrally isolate diagnostic atomic and molecular transitions arising within these atmospheres to study the physics of atmospheric mass-loss and possibly detect the presence of magnetic fields on exoplanets. The keys to unlocking the diagnostic potential of these systems are spectral coverage in the appropriate bandpass and the ability to follow the systems for several orbital periods. CUTE is designed to provide exactly that – low resolution spectroscopy of critical atmospheric tracers (Fe II, Mg II, Mg I, OH) that are inaccessible from the ground and a dedicated mission architecture that enables the necessary factor-of-twenty increase in survey time (relative to large treasury projects with the Hubble Space Telescope) required to characterize the atmospheric structure of these worlds. The CUTE instrument is comprised of a Cassegrain telescope (190mm × 85mm, f/2.5, primary) feeding a compact, low resolution (R = 2000) spectrograph operating from 2500 – 3500 Å. The spectrogram is recorded on a UV-optimized e2v CCD. Onboard data reduction is performed and data products are relayed to an existing ground station at the University of Colorado. This station currently serves as the ground segment for several cubesat payloads built and operated by students and researchers on campus. The science instrument is incorporated into a 6U form factor with a bus provided by Blue Canyon Technologies. The Blue Canyon bus provides power, command and data handling, attitude control, and communications. Blue Canyon and the instrument team at Colorado are located within 3 miles of each other, facilitating collaboration during the fabrication and integration of the CUTE payload. Calibration and testing will occur in the existing ultraviolet space-instrument characterization facilities at Colorado. CUTE will be developed in the framework of a university-led program where undergraduate, graduate, and postdoctoral training is paramount. The University of Colorado

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics Research and Analysis

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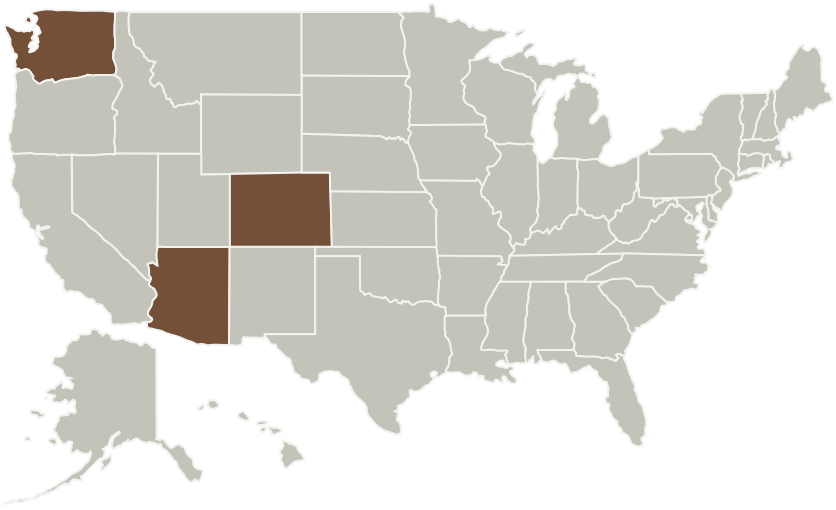
has a long history of training NASA's future leaders in space sciences, and the CUTE program will extend that heritage to a new generation of investigators with access to small satellite opportunities.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
Arizona	Colorado
Washington	

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Kevin France

Co-Investigators:

Nicholas Nell
Matthew Beasley
Keri Hoadley
Jean-michel Desert
Brian Fleming
Karen J Springfield
Aline A Vidotto
Pascal Petit
Luca Fossati
Richard A Kohnert
Tommi Koskinen

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System